XIV. *Experiments on Water obtained from the melted Ice of Sea-Water, to aſcertain whether it be freſh or not; and to determine its ſpecific Gravity with reſpect to other Water. Alſo experiments to find the Degree of Cold in which Sea-Water begins to freeze. By Mr.* Edward Nairne. *Addreſſed to Sir* John Pringle, *Bart. P. R. S.*

TO SIR JOHN PRINGLE, BART. P. R. S.

Hampſtead,
Feb. 1, 1776.

SIR,

R. Feb. 1, 1776.

IT having been ſuggeſted, in a converſation at which I was preſent, that the ice of ſea-water is not freſh; and that if the ice found near the poles be really ſo, it muſt probably be the ice of freſh water diſcharged into the ſea from large rivers in thoſe parts: I thought the preſent cold weather afforded an opportunity too favourable to be loſt, of aſcertaining by experiment, whether the water obtained from the melted ice of ſea-water be free from the taſte of ſalt or not; of comparing its gravity with that of the ſea-water, &c.; and of finding the degree of cold in which the latter begins to freeze: and I beg leave to lay before you an account of my reſearches in theſe matters, and of the methods I followed in making them. If you, SIR, ſhould think them worthy of notice, and would communicate them to the learned body over which you preſide, you would confer an honour on, &c.

THE ſea-water uſed in the following experiments was furniſhed by Mr. OWEN, who keeps the Mineral Water Warehouſe, at Temple Bar; who aſſured me, that it was taken up off the North Foreland.

On the 27th of January, 1766, at ten o'clock in the evening, I filled a jar 3¼ inches in diameter and 6½ inches deep, with ſea-water, and expoſed it to the open air, the thermometer ſtanding at 15°. At noon the next day, on taking it in, I found it frozen very hard, except a very little at the bottom, which remained quite fluid: I now ſet it by a ſtove in a heat of 56° to thaw. The ice when taken in from the open air was one quarter of an inch above the edge of the jar. When the jar had continued in the degree of heat abovementioned during eight hours, I took out the ice, which was then 3½ inches long and two inches in diameter; about two-thirds of the water appeared to remain. In order to clear the ice from any brine that might adhere to it, I waſhed it in a pail of pump water, in which it was ſuffered to remain about a quarter of an hour, and then ſet it in a ſieve to drain off the water in which it had been waſhed.

On the 29th of January, 1776, I ſet the beforementioned ice in a baſin in a heat of about 46°, in which it continued nine hours before the whole was diſſolved. The bulb of a thermometer reſted on the ice during the time of the ſolution, and continued without variation at 32°. The water thus obtained was, to my palate, perfectly free from any taſte of ſalt.

In

In order to aſcertain the comparative gravity of this water, I filled a bottle with it to a certain mark in its neck, which was very narrow, and weighed the bottle ſo filled very carefully. I weighed the ſame bottle, filled to the ſame mark in its neck with ſea-water and other waters ſucceſſively, which were all brought to the ſame degree of heat by a thermometer. The reſults were as follow; *videlicet*,

	Grains.
Water obtained from the melted ice of the ſea water,	1614
Diſtilled rain water,	1612
Water taken out of a water tub, being a mixture of rain and ſnow water,	1615
The ſea water,	1653
The *reſiduum* of the ſea water from which the ice before mentioned had been taken,	1659

To find the degree of cold in which ſea water begins to freeze, I made the following experiments.

I expoſed to the open air a decanter filled with the ſea water, in which a thermometer was ſuſpended, the bulb of which reached to the middle of the wideſt part of the decanter; a jelly glaſs filled with the ſame ſea-water, in which alſo a thermometer was put, reſting on the bottom, was placed in the ſame expoſure. The reſult will be ſeen in the following table:

January 29, 1776.

Veſſel.	Time.	Immerſed Therm.	Therm. in the open Air.	Effects, &c.
	h '			
Decanter,	11 30A.M.		19	
Jelly glaſs,				
Decanter,	12 0	33	19	A number of beautiful feathered cryſtals appeared in the jelly glaſs; they began to ſhoot from the top, which was covered with ice, toward the bottom; when they reached it, the thermometer roſe immediately from 25 to 28.5.
Jelly glaſs,		25 to 28.5		
Decanter,	12 15	31	19	Ice began to form in the decanter, though hardly perceptible at the edge of the water.
Jelly glaſs,		28.5		
Decanter,	12 20	30		
Jelly glaſs,		28.5		
Decanter,	12 30	29	19	Cryſtals of a laminated appearance began to ſhoot downwards obliquely from the ice at the ſurface, which at the edge of the water was barely two-tenths of an inch thick; no appearance of ice in the middle of the ſurface.
Jelly glaſs,		28.5		
Decanter,	1 0P.M.	27.5	19	Cryſtals began to ſhoot round the neck of the decanter cloſe to the glaſs.
Decanter,	1 15	28.5	19	The inſide became covered with finely feathered cryſtals, which made it impoſſible to obſerve the height of the thermometer, without raiſing it till the quickſilver in the tube appeared above the ice.
Decanter,	4 0	28.5	19	

January 29, at eight o'clock in the evening, I expoſed to the open air two ſimilar jars, each $5\frac{1}{2}$ inches deep and $1\frac{7}{10}$ inch in diameter; one of which I ſhall, for the ſake of diſtinction, call A; the other, B. A was filled with the ſea water; B with water taken out of a water tub, which was a mixture of rain and ſnow water. In A two thermometers were placed; one reſted on the bottom; the upper part of the ball of the other was a quarter of an inch only below the ſurface of the water; one thermometer was alſo placed in B, reſting on the bottom. The following table ſhews the reſult.

Veſſel.	Time.	Therm. at the Top.	Therm. at the Bottom.	Therm. in the open Air.	
	h ′				
A	8 0P.M.	60	60	19.5	
B			60		
A	8 15	40	33		
B			38		
A	8 20	35	29.5		
B			37.5		The ſurface of the water in B covered with ice.
A	8 25	31	26.5		
B			34		Surface as before.
A	8 30	29	25		No appearance of ice.
B			32		The ice on the ſurface increaſed.
A	8 32	28.5	24.5		Ice began to appear on the ſurface.
B			32		Quite frozen.
A	8 36	28.2	28.5		Cryſtals over every part of the glaſs.
B			32	20	As before.

N. B. During the time in which theſe obſervations were made, the thermometer in the open air roſe half of a diviſion.

The

The following table ſhews the reſult of ſome further obſervations on the effects of cold on the ſea-water in the jar A of the laſt table, which had been thawed in order to be now expoſed again to the open air. The thermometers in the jar continued in the ſame ſituation as before.

January 30, 1776, A. M.

Time.	Therm. at the Top.	Therm. at the Bottom.	Therm. in the open Air.	Effects, &c.
h ′				
10 32	34.5	35.5	16.5	The water fluid.
10 39	29	32		Ice began to be formed about the glaſs at the edge of the water.
10 42	28.5	30.5		Still continued to have ice only about the edge of the water.
10 48	28	28		The ſurface of the water rendered ſtagnant by the ice.
11 1	27	24.5	18.5	The cryſtals had almoſt reached the bottom.
11 1½ 2	27 +	28.5		During the half minute employed in this obſervation, the cryſtals reached the bottom of the jar; the lower thermometer roſe almoſt inſtantaneouſly from 24.5 to 28.5, and was immediately rendered obſcure by the ice.
11 45	26.5	28.5	19	The jar was taken in from the open air, and the lower thermometer lifted out of the ice to a ſufficient height for the obſervation.

From theſe obſervations it ſeems that the freezing point of ſea-water ſhould be fixed in FAHRENHEIT's ſcale at 28.5.

As the water, when it began to freeze in two experiments, exhibited phenomena different from any I had obſerved before, it may not be improper to ſubjoin an account of them.

At fourteen minutes after eight in the morning of January 31, I put the jar B of the ſecond table, containing the ſame water; *viz.* a mixture of rain and ſnow water, in a window, having the evening before placed a ſecond thermometer in it, the bulb of which was juſt below the ſurface of the water. This as well as the thermometer at the bottom ſtood at 27.5, and the water was perfectly fluid: the thermometer placed near the jar within the window was at 23.5. At twenty-ſeven minutes after eight it began to freeze at the bottom of the jar, the thermometers at the top and bottom ſtanding alike at 27. The inſtant the cryſtals began to encompaſs the ball of the thermometer below, which they very ſoon did after it began to freeze, the quickſilver roſe in it to 32°, the upper one continuing at 27°. The cryſtals continued to ſhoot upward, and in leſs than half a minute reached the bulb of the thermometer at the ſurface, which immediately roſe to 32°.

At ten minutes before ſix in the evening of the ſame day, I put the jar A of the ſecond table into the open air, its contents the ſame; *viz.* ſea water. The thermometers in it were likewiſe the ſame, not having been moved; they both ſtood at 34°; that in the open air at 19.5. At ſix o'clock the thermometer above was at 31°, that below at 28.25. At this time I diſcovered ſome ice on the ſurface of the water; but as it was by candle-light, I could not diſcern its firſt appearance. At ten minutes after ſix, the thermometer above was at 29°; that below at 26.5. At fifteen minutes after ſix, the upper thermometer at

28.5; that below at 25°. At ſeventeen minutes after ſix, both the thermometers ſtood at 28.5, cryſtals having riſen from the bottom covered the ball of that below, on which it roſe inſtantly from 25° to 28.5. The thermometer in the open air continued as at firſt; *viz.* at 19.5.

The ſcale of all the thermometers uſed in theſe experiments was FAHRENHEIT'S. I have ſent herewith ſpecimens of the water; *viz.* of the ſea-water; of the water procured from its melted ice; and of the *reſiduum* of the ſea-water from which the ice was taken.